Introduction

LVDC distribution systems have the potential to support future realisation of smart grids functionality. They do however present significant protection challenges that existing schemes based on DC fuses and conventional circuit breakers cannot manage due to slow device performance. Therefore, this research introduces an advanced protection scheme that addresses the outstanding challenges facing realisation of last mile DC distribution. The developed scheme has been validated using experimental testings.

Why LVDC protection is an issue?

- Very high transient DC fault currents
- Slow performance of existing LV non-unit protection schemes
- Sensitive devices become defenceless against high transient DC faults
- The rapid depression of DC voltages will spread due to the limited impact of cable reactance leading to unnecessary converter trips, and poor protection selectivity.
- Power quality issues due to high post-fault transient spikes of DC voltages
- Sympathetic tripping of local microgeneration against remote DC faults

Multifunction protection algorithm

- Measure (mag and dir) & Vol at each IED
- If V within the numerical limits NO
- The converter IED current direction is (+) and the feeder IED is (-) NO
- The fault is located at the PCC, the AABC is tripped and all downstream operators are tripped YES
- The end user is faulted and its local SESC directly operates YES
- The fault is on the main header, and its IED trips the associated SESC and reverses tripped all the operators connected to the feeder YES
- The SESC remains open NO
- The fault is temporary NO
- The fault is permanent NO
- Reclosing function is performed and loads are energised

Test Results

Fault1

Fault2

Fault3

Conclusions

- The developed DC protection scheme has demonstrated more resilient LVDC network performance by offering the following protection functions: fast detection of DC fault, good selectivity level, interrupting DC faults at low levels, and blocking reverse DC fault.
- The AC-DC converter and local generation ride through capabilities can be improved by interrupting the DC faults during capacitors’ discharging periods.
- This work has supported IEC SG4 and the IET LVDC power systems code of practice